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## Research Article

# Peritoneal catheter survival: The impact of unroofing

## Summary

**Background:** Unroofing is a controversial procedure to avoid catheter removal in the treatment of the chronic exit site and tunnel infection, but is now rarely recommended. Here we aimed to evaluate the effects of the unroofing procedure on peritoneal catheter survival.

**Methods:** From our database, we prospectively evaluated the outcome of 139 peritoneal catheters placed in 121 patients (1.14 catheters per patient, 73 female, 48 male) from 08-03-1993 to 12-31-2016. Twenty-three infected catheters needed surgical unroofing of the tunnel tract. We calculated the cumulative catheter survival rates (Kaplan-Meier) of 1) overall catheters and 2) not unroofed catheters, considering catheter removal as an endpoint. We also calculated 3) the unroofed catheter survival, considering the date of unroofing or catheter removal as the endpoint and, 4) continuity of the unroofed catheters post-unroofing, considering the unroofing date as if it were a new catheter and catheter removal as the endpoint. Likewise, we compared the survival of: a) unroofed catheters vs. continuity of the unroofed catheters and, b) no unroofed catheters vs. continuity of the unroofed catheters (Log-rank test) (significance value  $P < 0.05$ ).

**Results:** 1) The overall catheter survival rates were 94%, 84%, 76%, 55%, 40% and 26% at 12, 36, 60, 84, 120 and 210 months respectively. 2) The not unroofed catheter survival rates were 93%, 83%, 77%, 59%, 44% and 44% at 12, 36, 60, 84, 120 and 210 months respectively. 3) The unroofed catheter survival rates were 84%, 53%, 31%, 23% and 9% at 12, 36, 60, 84 and 120 months respectively. 4) The post-unroofed catheters survival rates were 91%, 77%, 66%, 66%, 50% and 33% at 12, 36, 60, 84, 120 and 160 months respectively. We detected a statistical significance when comparing unroofed catheters vs. continuity of the unroofed catheters and no statistical significance was observed when comparing not unroofed catheters vs. continuity of the unroofed catheters post-unroofed.

**Conclusion:** The overall catheter survival was satisfactory. Unroofing contributed significantly in the lifespan of the catheters.

## Introduction

Infection of the peritoneal catheter during peritoneal dialysis can facilitate entry of microorganisms into the peritoneal cavity, leading to peritonitis. Failure to cure these infections can lead to the removal of the peritoneal catheter and, thus, technique failure or other more severe scenarios. Likewise, frequent infections of the exit site, often chronic, generate the continuous use of antibiotics, facilitating the appearance of Gram-negative exit site infections and fungi peritonitis [1]. In the latest recommendations for International Society for Peritoneal Dialysis (ISPD) infectious complications for the catheter exit site, there is no mention of how to avoid the removal of peritoneal catheters in cases of chronic infections [2-4]. This procedure, known as unroofing of the peritoneal catheter, is nowadays rarely recommended.

Some articles have described the technical characteristics

of the procedure and their outcomes in adult and paediatric patients, as well as other subcutaneous surgical techniques to avoid catheter removal, but no articles have investigated the long-term durability of unroofed catheters [5-9]. In this work, we share our experience of many years of follow-up in the evolution of our peritoneal catheters and the impact of the unroofing on catheter survival.

## Materials and Methods

From our database, we prospectively evaluated the outcomes of 139 peritoneal catheters (34 Tenckhoff straight, 104 Swan Neck and 1 Missouri) placed in 121 adult patients (1.14 catheters per patient); 73 female, 48 male; mean age  $52.97 \pm 15.32$ -years-old; time at risk  $6672 \pm 48$  patient months; 19% diabetics) during the period 08-03-1993 up to 12-31-2016. Twenty-three persistently infected catheters needed surgical unroofing of the tunnel tract. The unroofing procedure essentially consist

by incising the skin from above the superficial cuff and the exteriorization of the subcutaneous external cuff removing the infected tissue many times helped by an electrosurgical knife. After sanitized the wound, absorbent monofilament threads are used to repair the subcutaneous tissue, finally, suture the skin [5]. In our protocol we do not shaving the exteriorized cuff.

We calculated the cumulative catheter survival using the Kaplan-Meier method of: 1) overall catheters, 2) not unroofed catheters, considering in (1) and (2) the catheter removal as an endpoint. Also, we measured 3) the unroofed catheter survival (considering the date of unroofing or catheter removal as an endpoint) and 4) continuity of the unroofed catheters post-unroofing, considering the unroofing date as if it were a new catheter and catheter removal as the endpoint. Death of the patients, renal transplant or transfer to another dialysis centre were censored. We compared the survival of: a) unroofed catheters vs. continuity of the unroofed catheters and b) no unroofed catheters vs. continuity of the unroofed catheters. To compare the survival curves, we used the log-rank test (significance value  $P < 0.05$ ). We also used the Chi-Square test to analyse the proportion of unroofing between Tenckhoff and Swan Neck catheters (significance value  $P < 0.05$ ). Data were analysed using the software IBM-SPSS statistic, version 24.

## Results

Of the 139 peritoneal catheters placed during the study period, 23 (16.54%) with chronic refractory infection were unroofed. The overall catheter survival was 94%, 84%, 76%, 55%, 40% and 26% at 12, 36, 60, 84, 120 and 210 months respectively, (median survival time, 105.8 months; 95%CI, 74.5–137) (Figure 1). The survival rates of the not unroofed catheters were 93%, 83%, 77%, 59%, 44% and 44% at 12, 36, 60, 84, 120 and 210 months respectively (median survival time, 111.7 months; 95%CI, 70.4–153) (Figure 2). Unroofed catheter survival, using the date of unroofing or catheter removal as the endpoint, was 84%, 53%, 31%, 23% and 9% at 12, 36, 60, 84 and 120 months respectively (median survival time, 44.3 months; 95%CI, 27.3–61.2) (Figure 3). The evaluation of the post-unroofed catheters survival was 91%, 77%, 66%, 66%, 50% and 33% at 12, 36, 60, 84, 120 and 160 months respectively (median survival time, 108.3; 95%CI, 32.7–184) (Figure 4).

An important statistical significance was observed when comparing catheters before unroofing vs. continuity of these unroofed catheters post-unroofed ( $P < 0.05$ ) (Figure 5). No statistical significance was observed when comparing not unroofed catheters vs. continuity of the unroofed catheters post-unroofed ( $P = 0.64$ ) (Figure 6).

Twelve out of 34 straight Tenckhoff and 11 of 104 Swan neck catheters required unroofing. Therefore, there was a greater need for this procedure in the former than the later catheters ( $\chi^2 P < 0.05$ ).

## Discussion

Similar to arteriovenous fistula survival for haemodialysis, catheter lifespan is an important indicator of the quality of the peritoneal dialysis programs. In patients undergoing

chronic haemodialysis, the creation of a new arteriovenous fistula following vascular access failure likely has a different body sensation and uncertainty compared to the placement of a new peritoneal catheter for patients on peritoneal dialysis, especially when the indication of peritoneal dialysis was made because of the impossibility of continuing in haemodialysis. Since the beginning of the chronic peritoneal dialysis, the characteristic of the peritoneal catheters (length, shape, gauge, material, cuffs number, etc.), as well as their placement and survival, have been studied [9–11]. On the other hand,

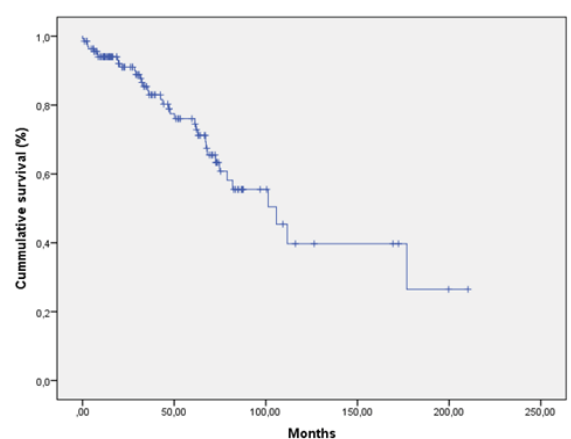


Figure 1: Overall Catheters survival.

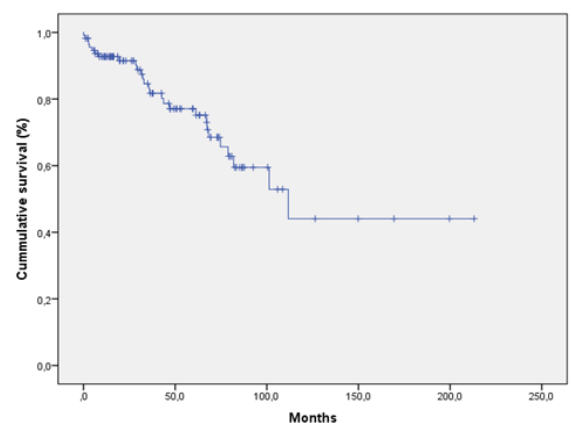


Figure 2: Survival of the not unroofed catheters.

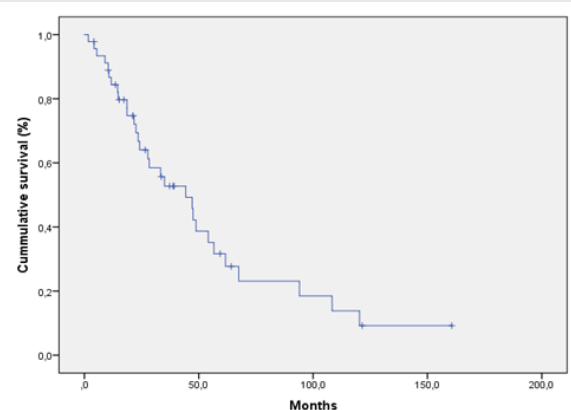


Figure 3: Unroofed or removed catheter as end point.

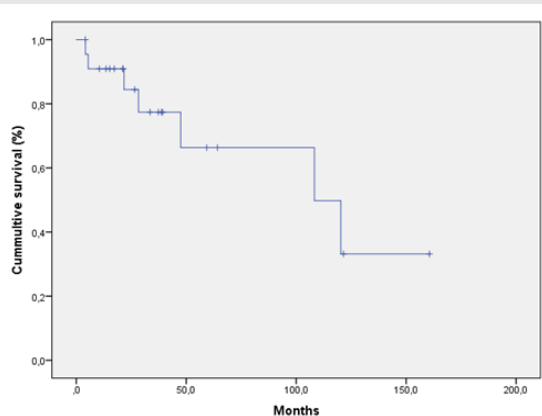


Figure 4: Post-unroofed catheters survival.

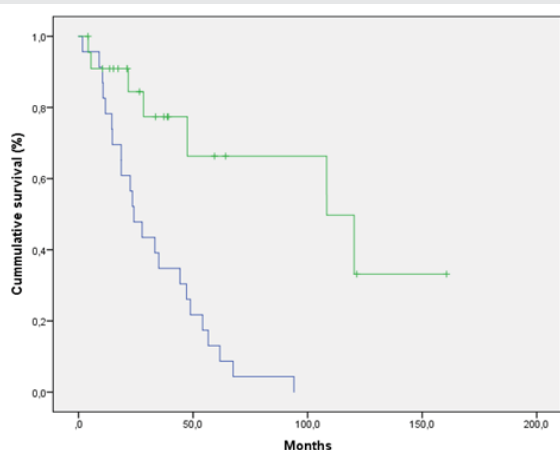


Figure 5: Unroofed or removed catheter as end point (blue) vs Post-unroofed catheters survival (green). Log rank  $P = 0.000$ .

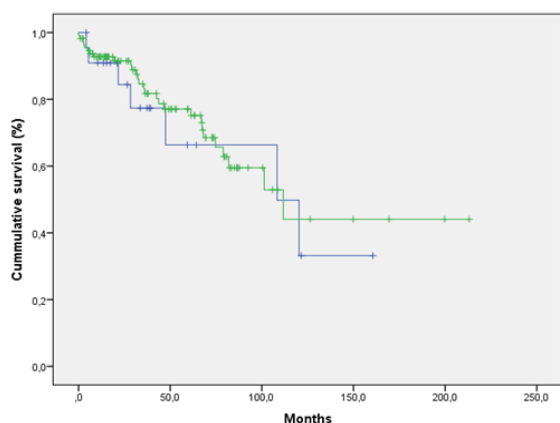


Figure 6: Survival of the no unroofed catheters (green) vs Post-unroofed catheters survival (blue), Log rank  $P = 0.64$ .

it is interesting to note that the survival rates of peritoneal catheters are equivalent to the survival of arteriovenous fistulas for haemodialysis [12–16].

During chronic treatments in which access to therapy depends on an artificial device, complications related to the material and methodology are inevitable. During peritoneal dialysis, patient compliance to the guidelines of care taught during the training of the technique is important.

Exit site infection is an important threat to catheter survival and, therefore, of the continuity of treatment in peritoneal dialysis. The therapy of this infection has been extensively studied in numerous articles and guidelines of the ISPD [17,18]. However, a known procedure to safeguard the peritoneal catheter, known as unroofing, has been little recommended due to disparate results, small samples of patients, and short follow-up periods [19–25].

During the evolution of our peritoneal dialysis program, we performed a thorough follow-up of catheter survival and the impact of the unroofing on the extension of the useful life of the catheters. We found that long-term overall catheter survival is satisfactory [9,26,27]. The survival of unroofed catheters (considering the date of the procedure as if day-zero of a new catheter) was similar to that of not unroofed catheters. Thus, there was a positive contribution of this procedure to the overall survival of catheters.

It is recognised that there are no differences in the outcomes when comparing different types of peritoneal catheters [28,29]. Shape memory of the peritoneal catheters has been implicated in the catheter migration process [30]. In a prospective randomised study, Lye and co-workers observed that the Swan neck configuration resulted in a significant reduction in the rate of exit-site infection [31]. In our study, it is important to highlight that the Tenckhoff catheters had the highest proportion of infected catheters that required unroofing; it seems likely that catheter migration related to the shape memory of the straight catheters will have facilitated the exit site erosion and secondary infection.

## Conclusion

The overall long-term catheter survival rate was satisfactory. Unroofing contributed significantly to the lifespan of the catheters. This simple procedure should be considered in persistently infected catheters before deciding to remove the catheter.

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